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Proceedings of the Regional Peer Review Meeting of the Stock Assessment and Management Advice for the British Columbia Pacific Herring Stocks: 2012 Status and 2013 Forecasts

September 5 and 6, 2012

Nanaimo, BC

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

These Proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Advisory meeting held September 5th and 6th at the Pacific Biological Station in Nanaimo, B.C. A working paper focusing on stock assessment of Pacific herring in British Columbia for 5 major areas and 2 minor areas was presented. A draft Science Advisory Report was developed to document science advice regarding harvest and recommendations for future research.

Participation included Fisheries and Oceans Canada (DFO) Science and Fisheries and Aquatic Management Sectors staff; and external participants from First Nations organizations (the Haida First Nation, the Heiltsuk First Nation), the commercial fishing sectors (the Herring Conservation Research Society), the recreational fishing sector (the Sport Fishing Advisory Board), the province of British Columbia, and academia (University of British Columbia and Simon Fraser University). No remote (webinar) participation occurred for this meeting.

The Working Paper and results of the assessment model and forecasting methods were accepted but some revisions to the Working Paper were suggested. The meeting also included discussions related to future work.

Science Advisory Report and Research Document resulting from the current Working Paper, when published, will be made publicly available on the CSAS Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

Compte rendu de la réunion régionale d'examen par les pairs de l'évaluation des stocks de hareng de la Colombie-Britannique et avis pour la gestion : évaluation de 2012 et prévisions pour 2013; les 5 et 6 septembre 2012

SOMMAIRE

Le présent compte rendu résume l'essentiel des discussions et conclusions de la réunion régionale consultative de Pêches et Océans Canada (MPO) et du Secrétariat canadien de consultation scientifique qui a eu lieu les 5 et 6 septembre à la station biologique du Pacifique de Nanaimo, en Colombie-Britannique. Lors de cette réunion, on a présenté un document de travail sur l'évaluation de stocks de harengs du Pacifique en Colombie-Britannique dans cinq zones principales et deux zones secondaires. On a également élaboré une ébauche d'avis scientifique afin de documenter un avis scientifique concernant la récolte et les recommandations visant à orienter les prochaines recherches.

Au nombre des participants à la réunion, il y avait notamment des représentants des secteurs des sciences et de la gestion des pêches et de l'aquaculture du MPO ainsi que des représentants externes d'organisations des Premières Nations (Premières Nations Haïda et Heiltsuk), du secteur de la pêche commerciale (Herring Conservation Research Society), du secteur de la pêche récréative (Conseil consultatif sur la pêche sportive), de la Province de la Colombie-Britannique et du milieu universitaire (Université de la Colombie-Britannique et Université Simon Fraser). Il n'était pas possible de participer à cette réunion à distance (webinaire).

On a adopté le document de travail et les résultats de l'évaluation du modèle et des méthodes de prévision, mais on a proposé quelques révisions au document de travail. Des discussions ont eu lieu au cours de la réunion au sujet des travaux à venir.

L'avis scientifique et le document de recherche découlant du document de travail actuel seront rendus publics, après publication, sur le calendrier des avis scientifiques du SCCS à http://www.dfo-mpo.gc.ca/csas-sccs/index-fra.htm.

INTRODUCTION

A Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS), Regional Advisory Process (RAP) meeting was held on September 5th and 6th at the Pacific Biological Station in Nanaimo to review *"Stock Assessment and Management Advice for the British Columbia Pacific Herring Stocks: 2012 Assessment and 2013 Forecasts"*. The Terms of Reference (TOR) for the science review (Appendix A) were developed in response to a request for advice from *Fisheries Management*. Notifications for the review meeting were sent to representatives with relevant expertise from First Nations, commercial and recreational fishing sectors, environmental non-governmental organizations, academia, the provincial government and DFO science and fisheries management sectors. A meeting agenda (Appendix B) and working paper (WP) were prepared and distributed to participants prior to the meeting (WP summary Appendix C).

The meeting Chair, Linnea Flostrand, welcomed participants and reviewed the role of CSAS in the provision of science advice, described applicable publications (Science Advisory Report, Proceedings and Research Document) and gave a general overview of the CSAS process, including the role of participants and the definition of consensus in the context of science advice.

The Chair reviewed the Terms of Reference and meeting agenda and also went over the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation. Members were reminded that everyone at the meeting had equal standing as participants and that they were expected to contribute to the review process if they had information or questions relevant to the paper being discussed. The Chair invited all participants to introduce themselves and their affiliation. Everyone was invited to participate fully in the discussion and to contribute knowledge to the process, with the goal of delivering scientifically defensible conclusions and advice. In total, 42 people participated in the review (Appendix D). Kristen Daniel and Roger Kanno were identified as the Rapporteurs for the meeting.

Review

Working Paper: Stock Assessment and Management Advice for the British Columbia Pacific Herring Stocks: 2012 Assessment and 2013 Forecasts, *by Jaclyn Cleary, Vivian Haist, Jake Schweigert and Steven Martell (CSAP WP2012-P08)*

Rappoteur(s): Kristen Daniel and Roger Kanno

Presenter(s): Jaclyn Cleary and Jennifer Boldt

Presentation - J. Cleary

The presentation was based on information included in the Working Paper, related to:

- background context (objectives, and descriptions of 5 major and 2 minor areas);
- updated data sets (commercial catch, spawn survey and biological samples);
- assessment model (outcomes of September 2011 and June 2012 reviews);

- stock status results (spawning stock biomass, depletion and recruitment trends), and
- forecasts and harvest control rule results as they relate to provision of advice.

Points of clarification (J.Cleary presentation)

An inquiry was made into why the B_0 confidence interval for the PRD is relatively wide. It was also later noted that SOG confidence interval is also relatively wide. Response: The estimates are very sensitive to changes in model assumptions, especially for the PRD. For the PRD, there have been past problems with positive retrospective bias, there are possible stock structure issues, and some uncertainty about historical catch locations, in addition to uncertainty related to quality of sampling data and survey coverage (topics discussed at June review).

Someone asked why estimates of B_0 for HG and WCVI seem relatively low. Response: Strong year classes affect B_0 estimates and these areas appear to be very sensitive to this variability (Figure 13 recruitment plots were used to show trends with strong year classes). For example, HG had 2 very strong year classes whereas the SOG shows less variation. B_0 is based on average time series and some biomass estimates in time series show estimates above B_0 , related to good recruitment years.

The use of poor, average and good recruitment categories in the harvest control rule was questioned, and whether it wouldn't be preferable to use the model to forecast recruitment for all stocks or at least HG, PRD and CC (i.e. from stock recruitment function). Response: The history of this approach (1980s) was to provide some flexibility to fisheries managers at a time when models weren't as advanced as they are now. This was identified as a topic for further discussion.

Clarification was sought on points and trend lines of Figure 10. Response: Different abundance measures are raw spawn index observations (points) and modeled spawn survey abundance estimates are scaled by q estimates (lines).

It was questioned why in some areas q1 (for surface survey period) is greater than q2 (for the dive survey period). The similarity between q1 and q2 for the SOG was also queried. Response: Uncertainty in these q trends was documented as outstanding issues in Martell et al (2012) but for the SOG it was suggested that survey documentation for this area was generally better than other areas because of proximity to human population centers (easier to observe). Furthermore, surface and dive survey comparisons were undertaken in SOG in the mid 1980s and therefore conversions are thought to better than other areas (where not done).

Concern was expressed over effects of inter-annual changes in spawn survey coverage (effort) over the time series. Any reductions in survey coverage after 2006 (from reduced resources) would violate assumption of constant q and introduce bias to analyses. Perhaps it is better to treat the spawn data as a relative rather than absolute index? Response: Difficult to model changes in coverage affecting q because spawn survey has the issue of being "presence only" data.

There was concern that B_0 will be biased low by leaving out SOK catches (eggs removal and handling mortality). It was noted that spawner biomass per unit spawn relationships (not shown) have declining trends (especially last 5 years), with no biological explanation.

The question was asked whether we are at the point where there is too much uncertainty from degraded sampling coverage to effectively forecast biomass? Response: Authors do not think so but it was stated that the better question is how do we best allocate limited resources to get job done?

Selectivity effects of combining test and commercial biological sample data were questioned. Response: This topic has received some consideration (Haist and Schweigert 2007) and results suggested some differences in size selectivities but it doesn't appear to be a major issue.

A retrospective analysis on q estimates was suggested. Response: Results from analyses were shown (not part of WP) and q estimates appear fairly stable.

It was mentioned that spawn survey coverage in the CC has increased since the commercial roe fishery has been closed. This was attributed to DFO funding of 3 Heiltsuk spawn survey vessels, which have enabled areas other than those where commercial fisheries were typically located to be surveyed.

The accuracy of at least two biosample locations mapped in Figure A.7 was questioned; therefore coordinates need to be checked.

It was asked why 0.25 B_0 decreased so much from the addition of the recent year's data. Specifically, when comparing estimates of B_0 (and $0.25B_0$) from Martell et al 2012 with retrospective estimates representing 2011 (WP Table 6, page 30), the current retrospective estimates are considerably lower (~15-25%). For example, the HG B_0 estimate reported in the 2011 SAR is 41,740 whereas the retrospective 2011 estimate reported in the WP is 33,753. Response: Authors used HG as an example to show how the combination of coding and data changes between methods applied for Martell et al (2012) and WP caused the variation in B_0 (median posterior estimates provided): 2012 code and 2012 data = 35,567 t; 2012 code and 2011 data = 37,152t; 2011 code and 2011 data = 40,855t. One notable data difference that was identified was that the 2011 assessment (Martell et al 2012) included a time series for SOK spawn data that informed spawn biomass estimates (but no SOK mortality was accounted for), whereas the 2012 assessment excluded modeling SOK catch and mortality completely. Changes to model were made prior to and for June WP that was reviewed. Authors were requested to report changes to data sets and coding (methods) as a revision for research document. Authors agreed to investigate and document in more detail.

There was still concern over the changes in revised B_0 estimates between 2011 and current assessment. This was identified as a topic of uncertainty needing further clarification.

Presentation- J. Boldt

The presentation was based on information included in Appendix E of the Working Paper. Titled "2013 recruitment forecast for West Coast of Vancouver Island and Strait of Georgia Pacific herring", (authors J.Boldt and R. Tanasichuk). Topics related to:

- WCVI La Perouse survey background (objectives, study area, role associated with CSAP approved recruitment forecasting method);
- Field methods (data collection, survey design, data collection, catch per unit effort (CPUE));
- Survey results (catch, CPUE, length and age data, calculated proportion age 2+);

- Forecasting methods (logit regressions, assessment model output numbers of age 3++, proportions age 2+);
- 2013 age-3 forecasts (millions of fish) from La Perouse survey, WCVI poor; SOG good;
- 2012 sardine survey data from La Perouse area (new dataset) exploratory methods and results.
    - 2013 age-3 forecasts from 2012 sardine survey: WCVI poor but varying forecasts for SOG (poor or average).

Points of Clarification (J. Boldt presentation)

Given the performance of the forecast in the last 11 years, it was questioned whether this forecasting is appropriate. Response: The methodology went through the CSAP approval process (Tanasichuk 2002) and accurately forecasted poor for SOG for 2008 and 2010 spawning years, thus reliably detected the 2005 and 2007 poor year classes. The retrospective analysis was only done for the last 11 years but will be extended to include all years (when the forecast was done) to account for changes in assessment models over the time series. The longer timeframe for the retrospective analysis will improve our understanding of the recruitment performance. Currently, forecasts of a given year are compared to the assessment model output of the same year; alternatively, forecasts could be compared to the most recent model time series of recruitment estimates.

It was questioned why the SOG juvenile herring survey data are not used to forecast SOG recruitment. Response: The samples from the 2011 survey have not been processed yet due to other priorities but will be presented in the future.

It was noted that the data used in the recruitment forecast regression relationship should be from the same general source (i.e. real data versus real data, or, model data versus model data). The reason for using this regression is to convert the field-estimated proportion of age 2+ fish to the same scale as that in the assessment model.

Addendum:

Subsequent to the CSAS review meeting, during the finalization of this year's CSAS herring stock assessment documents, an error was detected in the recruitment forecast for the SOG and WCVI. Application of the methodology for the categorization of the forecasted recruitment into one of three categories (Poor, Average, and Good) was misinterpreted. As a result, the forecasted recruitment was compared to breakpoints in the historic stock assessment recruitment time series, rather than to the current stock assessment recruitment time series. The stock assessment age 3 abundance time series that should have been used was the updated values (1951-2012) produced by the 2012 assessment, instead, the 2011 time series was used with an updated value for 2012. This error was corrected and, as a result, the expected recruitment forecast changes for the Strait of Georgia from good to average, which subsequently changed the 2013 forecasted biomass and potential commercial harvest. The recruitment forecast for the West Coast of Vancouver Island remains the same (poor). As this change was a calculation error only, no further review process was required. The Science Advisory Document and the Research Document will reflect the corrected forecast for the Strait of Georgia. An email was sent to meeting participants to advise of the post meeting corrections.

General Discussion

It was proposed that model projections of age-3 recruits be compared with results from recruitment forecasts from trawl survey.

Poor biosample representation and spawn survey coverage occurred in 2012 for the WCVI and the two datasets had contrasting effects on biomass trends, therefore additional uncertainty is associated with estimates for that area. No similar concerns arose for the other stock areas.

There was an inquiry about using herring data from other survey sources, such as the spring small mesh (shrimp) bottom trawl survey. Response: There has been some work done using other trawl survey data for forecasting purposes (Therriault 2003), and there is potential but with some constraints related to differences with gear (i.e. mesh size), fishing methods and survey design that affect CPUE estimates.

Attention was drawn to the biomass estimates and pre-fishery forecast estimates presented in Table 9, page 38 of WP and the group was asked if they are in agreement over endorsing the results as part of science advice. It was noted that there are no alternatives and we must work with what we have, which is a reasonable set of model results.

Some clarity on role of 0.25 B_0 in the harvest control rule and harvest rate ramping was requested. Response: 0.25 B_0 not designed as a limit reference point but as a commercial fishery threshold. Future work is required to look at biological reference points. In the 1980s, the 20% harvest rate was considered conservative and varying harvest rates (or investigating alternative rates) hasn't been done for herring in recent years.

A participant showed concern that current 0.25 B_0 for HG is too low and could allow for a fishery re-opening when biomass remains relatively low (also believed cutoff from 1996 was too low). Participant stated that spawn estimates shown on Figure 10 (page 18 WP) also appear low for HG based on traditional ecological knowledge of the region. Someone suggested that very high catches in 1950s and 60s are likely driving the estimate of B_0 and so it is less sensitive to recent changes in biomass estimates. But it was pointed out that B_0 from the 2012 assessment is less than B_0 from 2011 assessment but the current assessment shows B_{2012} increased from B_{2011} and it is still unclear why this occurred.

Concern was expressed about endorsing estimates of biomass when there is uncertainty about the assessment data and code used to generate results (referring to differences between 2011 and 2012 methods). A response to this was that modeling changes occurred but not errors, just changes made since last year and there is a need for more documentation on what those changes were and how they affected the results. There was consensus that this be part of revisions for research document.

A suggestion was made that revisions include only medians and 90% CI from posterior distributions of estimates in data tables because having MLE and medians in same document is very confusing. It was noted that all retrospective plots need to be done showing MLE estimates. There was consensus by the group that this would be desirable and authors agreed to make these revisions. It was emphasized that 90% confidence internals need to be included in the SAR as well as research document.

There was some discussion over the number and location of effective samples used for SOG and WCVI recruitment forecasting from the herring trawl survey. There was concern that fewer

samples were obtained in 2012 compared to previous years and whether sardine survey samples should be used in the herring recruit forecast. Author explained that the sample size from the herring trawl survey in 2012 was lower (due to fog, sport and other vessel traffic, and low herring school encounter rates) but when comparing the number of samples collected each year, sampling design and effective sample sizes should also be considered. Utilizing the sardine survey data in the herring recruit forecast added uncertainty to the SOG recruit forecast. Survey sampling design differences should be considered prior to incorporating the sardine survey data in the recruit forecasts. The sardine survey samples were collected during night time hours at pre-determined, randomly chosen stations (blind sets). Also, during the sardine survey the trawl net was towed at the surface. Use of sardine survey data is a new approach worth examining and testing on a longer time series.

An inquiry was made into the CSAP request process to review research associated with biological information that could affect assessment methods. Response: Although the number of herring reviews may not have increased, CSAP administration/ meeting support is at maximum capacity and there has been an increase in the number of requests and meetings annually. Requests are reviewed and prioritized for region by a committee. Relevance of proposed work should be discussed with managers and section heads to see if it aligns with other objectives.

Future Work Consideration

There was interest among participants to consider and discuss topics related to possible future work. To help focus discussion, the chair drafted and circulated a summary of topics identified at the September 2011 and June 2012 reviews. She explained that the list only reflects topics emphasized at the two previous CSAP herring reviews and that additional topics can be added to the list to keep an inventory. Appendix E is a collation of these and additional topics mentioned at the current meeting (noted below in no order of priority).

The SOG juvenile survey for recruitment forecasting was identified as a source of information that should be considered.

Account for SOK (egg removals and handling mortality) in the assessment model.

Investigate reductions in weight/ size at age trends and their effects on assessment model results.

Consider alternative uses of spawn data in the assessment, (i.e. other jurisdictions use a different approach). The idea of considering a coastwide measure of spawn length (and not worry about details of width or layers) was suggested.

Identify sampling issues biasing spawn survey information since spawn surveys have the greatest bearing on biomass estimates. If issues can be identified, then strategizes can be considered to correct for bias.

Evaluate and develop management procedures.

Evaluate changes in herring fecundity/ size of ovaries on population assessment results. There is ovary data from 1970s and a change can be detected for the mid 1980s. Increases in B.C. herring ovary size have been detected (the number of eggs per gram of total fish weight has increased and relative fecundity has changed) resembling those of California stocks.

Review sampling protocols and options (both biosampling and spawn surveys) in light of reduced science funding. It was explained that a request for science advice was submitted and signed off and this is a priority on DFO science workplan. Considering use of total spawn length and average width as main measure for spawn index was suggested. Different scenarios and sampling intensities should be considered for different areas.

Evaluate effects that harvesting algae (i.e.*Japonica*) may have at reducing herring spawn habitat. It was stated that ~ 5000 tonnes of product are proposed for annual harvest within Baynes Sound.

Investigate the effect of disease as a factor in increased natural mortality, and possibly suppressing HG, WCVI and CC stocks.

The group agreed that suggestions for future work should be evaluated and planned in a working group forum. A working group forum could also provide direction and support for research by graduate students (i.e. MSE work).

Science Advisory Report

A draft Science Advisory Report (SAR) was circulated for feedback on content and for development of conclusions and recommendations. A draft based on the SAR for the 2011 herring assessment (DFO, 2011) was prepared and circulated.to participants for discussion. The following specific edits and additions were agreed:

Summary: Results need to be updated with output from the current assessment. Clarification is required to identify that all biomass estimates are medians and 90% CIs (from current model output) and consistent wording and notation required related to spawner biomass (Bt not SSB).

Ecosystem Considerations: The role of this section was described as place holder for ecosystem science and management as it evolves. It was noted that it is difficult (and controversial) to develop this section when no formalized process for this topic. Suggested revisions include adding references about ecosystem trends (predators, state of the Pacific Ocean reporting) and inclusion of Coho and Chinook salmon into predator wording.

While reviewing this section of the SAR, it was suggested that uncertainty related to incidental mortality (in other fisheries) should be documented somewhere. Managers agreed to look into incidental catch of herring as source of mortality but as far as they knew this has not been flagged as a topic of concern. The development of a DFO bycatch and discard policy was mentioned.

Another topic that came up during discussions was that work by Schweigert et al (2010) suggests that increases in marine mammal populations but decreases in predatory fish species populations have balancing out effect on WCVI herring consumption rates over time series.

History of Catch: A suggestion was made to include minor areas in summary table.

Management Framework: Suggested revisions include:

-References need updating.

-Suggestion to clarify 0.25Bo and 0.31Bo in context of HCR.

-Suggestion to describe/distinguish SFF policy from herring HCR (and future work needs).

-Clarification to differentiate between FN commercial and Food Social and Ceremonial (FSC) harvests added (i.e. for Heiltsuk and SOK).

Assessment- Methodology and sources of information: Suggested revisions include:

-Adding wording about modeling changes and Bo changes between years. This is needed because some people are uncomfortable with those changes so they should be flagged.

Assessment- Stock status and trends: Suggested revisions include:

-Including a table that has estimates of Bt for 2008-2012 (all WP 2012 assessment results) because people want to see numbers in addition to trends.

-Each area summary needs to be updated with 2012 estimates and 90% CIs and qualifiers should be removed (i.e. words like "only, despite" etc).

-2W and 27 plots need inclusion (Figure 3).

-Age-3 recruitment plots needed (to become Figure 4).

Biomass Forecasts: Suggested revisions include:

-Reformatting of information in draft tables with 4+ biomass estimates (and their 90%CIs) and provide information in a format more like Table 9 of WP (but with CIs).

– Present a single maximum (potential) commercial harvest column.

Sources of Uncertainty: Suggested revisions include:

-Change wording in first sentence to "Recruitment *and natural mortality* are considered the most important processes determining the productivity..."(natural mortality added)

-Remove 2011 SAR information about PRD uncertainty and retrospective trends (because results for 2007 and later do not show positive bias).

- Add wording to capture issues with changing Bo as part of harvest control rule..

-Add wording to identify poor biosample and spawn survey coverage in the WCVI in 2012 (since some bio sample data inflate estimates and cause increasing trend from 2011 to 2012 but spawn survey data cause opposite trends).

There was some discussion on whether changes in spawn survey indices are biological or survey methodological. Some feel that there are decreases in egg layers but increases in spawn length over the relatively recent time series.

Conclusions and Advice: Suggested revisions include:

-Adding wording to identify that: "The model reviewed and approved in 2011, and further evaluated in 2012, was used to produce stock assessment and harvest advice...".

-Updating all results to reflect 2012 assessment output.

-Adding wording to identify that assessment model is reasonable but there is uncertainty with effectiveness of management framework.

-Adding wording that "HG, CC and WCVI stock all remain near historic minimums... therefore it is recommended that biologically based, limit reference points be developed to inform management and rebuilding strategies."

There was some discussion on the topic of evaluating the herring management framework. Objectives need to be identified for future/current SFF policy. No one was able to identify what objectives existed when current harvest control rule was determined. For future work considerations, a suggestion was made to refer to Schweigert et al (2007) "A risk assessment framework for Pacific herring stocks in B.C". Current policy states that 1) biological reference limits are needed before a rebuilding strategy is implemented, 2) a rebuilding strategy is needed before an area is re-opened after conservation closures, and 3) rebuilding strategies are supposed to take into account ecosystem considerations. Discussion also included noting that Science can inform on reference points but it is Management's job to decide how to implement the information.

CONCLUSIONS AND RECOMMENDATIONS

The paper was accepted but three key revisions were identified:

- having additional text describing changes (coding/methodology and data sets) that occurred since the 2011 assessment (i.e Martell et 2012) and the context of how the changes affected estimates of B_0;
- presenting medians and 90% confidence intervals of posterior estimates in summary tables (to reduce confusion with MLE estimates), and,
- include plots of the estimated numbers of age-3 recruits for the time series (replaces the age-2 plots provided in WP) .

There was consensus to forecast age-3 recruits for the 2013 season using previously agreed upon methods, whereby forecasts for the SOG and WCVI are based on the summer trawl survey observations and forecasts for the other three major areas are based on assignment rules, and forecasts for the minor areas (Area 2W and 27) are always "average". It was determined that stock recruitment forecasts are "poor" for the Haida Gwaii (2E), Central Coast and west coast of Vancouver Island, "good[1]" for the Strait of Georgia and "average" for the Prince Rupert District.

Haida Gwaii, Central Coast and west coast of Vancouver Island stocks all remain near historical low biomass levels. There has been little evidence of stock recovery in these areas, even with an absence of commercial fishing in recent years. The causes of the recent trends in low productivity in these areas are unknown, and more work is required to address this uncertainty,

[1] See text related to post meeting adjustments to this conclusion on page 10 of these proceedings.

related to ecosystem and environmental drivers. Therefore, it is recommended that biologically based, limit reference points be developed to inform management and rebuilding strategies.

Future work is recommended to evaluate management frameworks for Pacific herring stocks in the context of Sustainable Fisheries Framework policies (i.e. Precautionary Approach, DFO 2009), including policy implications of the structural changes to the model and any impacts on the performance of the existing harvest control rule. This includes investigation of the use of revised (annually updated) estimates of unfished biomass used to calculate 0.25Bo, as opposed to the use of a fixed cutoff (such as was implemented from 1996-2010).

Given the significance of recruitment to herring stock productivity, an evaluation of current recruitment forecasting methods and comparisons with other sources of data (e.g., Strait of Georgia and Central Coast juvenile herring inshore purse seine surveys) and modeling approaches warrants further research.

It is recommended that future research topics be evaluated and planned in a working group forum.

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APPENDIX A: TERMS OF REFERENCE

Terms of Reference

Stock Assessment and Management Advice for BC Pacific Herring: 2012 Status and 2013 Forecast

Regional Peer Review - Pacific Region

September 5-6, 2012
Nanaimo, BC

Chairperson: Linnea Flostrand

Context

Annually, an assessment of Pacific herring abundance and forecasts for the coming year is generated for each of the five major and two minor stocks in British Columbia, using a statistical catch–age-model. The assessment framework integrates data from sampling the population with analytical methods to model population dynamics and harvest control rule components. The annual assessment is reviewed through a Canadian Science Advisory Secretariat Regional Advisory Process (RAP) and harvest advice is provided to Fisheries and Oceans Canada (DFO) Fisheries Management each fall to inform the development of the Integrated Fisheries Management Plan (IFMP).

Refinements to the herring statistical catch-age model have occurred on an ongoing basis since the earliest version (Haist and Stocker 1984), with most recent major reviews in 2008 (Christensen et al. 2009), 2011 (Martell et al. 2012), and June 2012 (Cleary et al., *in prep*). The 2011 revisions include first steps in moving towards compliance with DFO's Sustainable Fisheries Framework (SFF) policy "A fishery decision-making framework incorporating the Precautionary Approach" (DFO 2009). This work, carried out by the Herring Assessment Team (DFO Science, academia and industry consultant), developed an alternate modeling framework to address some of the recommendations that have come forth at previous RAP reviews concerning model assumptions and decision rules. The most recent June 2012 meeting, "Evaluation of data and model assumptions on the calculation of management parameters using the Pacific herring assessment model", addressed concerns that arose in September 2011, as described in the meeting Proceedings (DFO 2012).

This RAP will present 2012 biomass estimates and forecasts for the 2012/2013 fishing season. Methods reviewed and approved at the June 2012 meeting will be used in the generation and provision of science advice for September 2012. The

Research Document to be presented will focus on the provision of science advice for the 2012/13 fishing season.

Objectives

1. What is the estimated 2012 spawning biomass for Pacific Herring by major and minor stock assessment area?

2. How are herring stocks in these areas changing over time?

3. What is the forecasted spawning biomass for 2013?

4. Are there any specific concerns that Fisheries Management should be aware of, and if so, what are those concerns?

The following working paper will be reviewed and form the basis for discussions and advice related to these objectives:

Stock Assessment and Management Advice for the British Columbia Herring Stocks: 2012 Assessment and 2013 Forecasts by Jaclyn Cleary, Jake Schweigert, Vivian Haist, Steven Martell (final authorship TBD). CSAP Working Paper 2012/P08.

Expected publications

- CSAS Proceedings (1)
- CSAS Science Advisory Report (1)
- CSAS Research Document (1)

Participation

- DFO Science Branch
- DFO Fisheries Management Branch
- BC Provincial government representation
- Commercial and recreational fishing interests
- First Nations organizations
- Non-government organizations
- Academia

References Cited and Additional Information

Christensen, L.B., Haist, V. and Schweigert, J. 2010. Modeling herring population dynamics. Herring catch-at-age model version 2. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/073. 65 p. http://www.dfo-mpo.gc.ca/csas-sccs/publications/resdocs-docrech/2009/2009_073-eng.htm

Cleary, J.S., Schweigert, J.F. and Haist, V. 2010. Stock assessment and management advice for the British Columbia herring fishery: 2009 assessment and 2010 forecasts. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/079. vii + 81 p.

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DFO. 2012. Pelagics Standing Committee reviews of: Stock assessment and management advice for the British Columbia herring stocks, 2010 assessment and 2011 forecasts, and Pacific herring biological sampling program design; September 1-2, 2010. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/058. http://www.dfo-mpo.gc.ca/csas-sccs/Publications/Pro-Cr/2011/2011_058-eng.pdf

Haist, V. and M. Stocker. 1984. Stock assessment for British Columbia herring in 1983 and forecasts of the potential catch in 1984. Can. MS Rep. Fish. Aquat. Sci. 1751: 50p.

APPENDIX B: AGENDA

Stock Assessment and Management Advice for BC Pacific Herring: 2012 Status and 2013 Forecast

September 5 and 6, 2012
Pacific Biological Station, Seminar Room

Centre for Science Advice Pacific

Chairperson: Linnea Flostrand

Day 1- Wednesday September 5

09:00	Welcome & introductions	Linnea Flostrand
09:10	Review agenda & housekeeping	Linnea Flostrand
09:20	CSAS overview & meeting procedures	Linnea Flostrand
09:30	Review terms of reference	Linnea Flostrand
9:45	Presentation: Stock Assessment and Management Advice for BC Pacific Herring: 2012 Status and 2013 Forecast	Jaclyn Cleary
10:45	**Break**	
11:00	Presentation: Summer La Perouse trawl survey findings and recruitment forecasts for WCVI and SOG.	Jennifer Boldt
11:40	Discussion of Results and Advice by region Order: HG, PRD, CC, SOG, WCVI, 2W, 27	All Participants
12:20	**Lunch Break**	
13:30	Discussion of Results and Advice by region continued	All Participants
14:45	**Break**	
15:00	Finalize conclusions and advice by region.	All Participants
16:30	***Adjournment***	

Day 2 – Thursday September 6th

9:00	Introductions & Housekeeping	Linnea Flostrand
9:15	Review Day 1 & Confirm Agenda for the day	Linnea Flostrand
9:30	Science Advisory Report *(draft will be circulated)* Develop Consensus on: • Key findings • Key conclusions and recommendations • Uncertainties • Ecosystem Considerations • Advice for Management • Recommendations for future work • Other	All Participants
10:30	***Break***	
10:50	Science Advisory Report	All Participants
12:05	***Lunch Break***	
1:05	Science Advisory Report	All Participants
3:00	Wrap-up, next steps, other business	
3:30	***Adjournment*** *(meeting may end earlier depending on meeting progress)*	

APPENDIX C: SUMMARY OF THE WORKING PAPER

B.C. herring stocks are managed as five major and two minor stock areas. Accordingly, catch and survey information is collected independently for each of these seven areas and science advice is provided on the same scale. All available biological data on spawn deposition, size and age composition of the spawning stocks, as well as commercial harvest data, were used to determine current abundance levels. In recent years external reviewers have suggested substantial revisions to the herring assessment framework, including revisions to the catch-age model. As such, a new integrated statistical catch-age model (ISCAM) for jointly estimating the abundance of Pacific herring stocks and associated reference points was developed and approved for the September 2011 stock assessment. This working paper was developed to address the following: (1) present the data used in the 2012 stock assessment of B.C. herring stocks, (2) provide a summary of the stock assessment model (ISCAM), (3) present the 2012 stock assessment and forecast for 2013, (4) discuss areas of uncertainty in the provision of science advice, and (5) provide harvest options based on the current herring control rule.

APPENDIX D: ATTENDEES

Last Name	First Name	Affiliation	Attend Sep 5	Attend Sep 6
DFO				
Boldt	Jennifer	DFO, Science	yes	yes
Boutillier	James	DFO, Science	yes	
Cleary	Jaclyn	DFO, Science	yes	yes
Daniel	Kristen	DFO, Science	yes	yes
Evanson	Melissa	DFO, FAM	yes	yes
Flostrand	Linnea	DFO, Science	yes	yes
Fort	Charles	DFO, Science	yes	yes
Fu	Caihong	DFO, Science	yes	
Goruk	Andrea	DFO, FAM	yes	yes
Haigh	Rowan	DFO, Science	yes	yes
Hall	Peter	DFO, FAM North Coast	yes	yes
Joyce	Marilyn	DFO, Science	yes	yes
Kanno	Roger	DFO, FAM	yes	yes
Kronlund	Rob	DFO, Science	yes	
MacConnachie	Sean	DFO, Science	yes	
Midgley	Peter	DFO, Science	yes	yes
Mijacika	Lisa	DFO, FAM	yes	yes
Palfrey	Terrence	DFO, FAM	yes	yes
Rutherford	Dennis	DFO, Science	yes	
Schweigert	Jake	DFO, Science	yes	yes
Spence	Brenda	DFO, FAM	yes	yes
Tanasichuk	Ron	DFO, Science	yes	
EXTERNAL				
Amoroso	Ricardo	UBC Fisheries	yes	yes
Ashcroft	Chuck	Sport Fishing Advisory Board	yes	yes
Benson	Ashleen	SFU post doc, Consultant,	yes	
Chalmers	Dennis	BC Ministry of Fisheries	yes	
Gladstone	Keith	Heiltsuk Nation	yes	yes
Haist	Vivian	Haist Consulting	yes	yes
Hamer	Lorena	Herring Conservation and Research Society	yes	yes
Hay	Doug	DFO Scientist Emeritus	yes	yes
Hessing-Lewis	Margot	SFU Hakai Network	yes	yes
Hrabok	Christa	A-Tlegay Fisheries Society	yes	yes
Humchitt	Carrie	Heiltsuk Tribal Council, HIRMD	yes	yes
Jeffery	Sharon	Haida Fisheries	yes	yes
Jones	Russ	Council of Haida Nation	yes	yes
Krenz	Dan	VIU, RMOT	yes	yes
Moody	Reg	Heiltsuk Nation	yes	yes
Morley	Rob	Canadian Fishing Company	yes	
Newman	Earl	Heiltsuk Nation	yes	yes
Rusel	Christa	A-Tlegay Fisheries Society	yes	yes
Safarik	Ed	Herring Conservation and Research Society	yes	
Starr	Paul	Consultant invited by HCRS	yes	yes

APPENDIX E: FUTURE WORK CONSIDERATIONS

The following list summarizes topics suggested future research consideration related to the assessment of Pacific herring stocks in British Columbia. The list is not prioritized. The meeting at which they were raised is noted in parentheses.

1. Explore possibility of fitting the assessment model to 2 independent sources of age composition data: test charter and commercial fishery data. (Sept 2011 and June 2012 – especially for PRD possible substock effects)

2. Model SOK product removal (egg loss and escapement) and mortality from closed ponds as they affect fishing mortality and spawner escapement estimates. Requires statistics on closed and open ponds and handling mortality. (September 2011, June 2012 and Sept 2012).

3. Partitioning and modeling sexes separately (Sept 2011 and Sept 2012).

4. Vary the standard deviation of the q prior (June 2012).

5. Explore alternate treatment of biological sample data and fishery selectivity issues. Considering time-varying selectivity (potentially caused by changes in weight data quality, fishing methods, and gear types, changes in ovary size), including treating males and females separately. (June 2012).

6. Evaluate (i.e. through simulation) age class modeling options. Sensitivity analyses show that biomass estimates are sensitive to changing pmin with multivariate logistic likelihood. Concerns about fish weight data quality (changes in methods and morphometrics over time). Suggestions included: rejecting weight based parameterization; consider length instead of weight, other? (June 2012).

7. Explore treating Areas 3 and 4 versus 5 separately as possible sub stocks of the PRD. Investigation of historical retrospective pattern (before 2007) indicated that removing some of the fall seine samples greatly reduced retrospective pattern. (June 2012).

8. Evaluate Herring Fishery Management Framework, SFF/ PA, MSE etc:
   a) Interim and long-term work plans related to evaluating and/or developing management frameworks and biological reference points are required (June 2012).
   b) To identify the parameters to include in future decision tables ongoing discussion between Science and Management is required. (June 2012).
   c) Evaluating constant values as reference points in management framework as opposed to using annually varying estimates of $0.25B_0$ (Sept 2012).

9. Evaluation of the different recruitment forecasting methodologies: model predictions (i.e. Bayesian), juvenile SOG and CC survey results and LaPerouse trawl survey results (Sept 2012).

10. Investigate causes for changes in spawn layers estimates over time series: biological versus methodological (Sept 2012).

11. Investigate alternative stock assessment sampling designs with reduced resources (CSAP request for science advice was submitted and has been approved, on workplan (Sept 2012).

12. Investigate decreases in weight and/or size at age over time series and sensitivity of assessment results (Sept 2012).

13. Investigate changes in ovary size and fish size and effects of fecundity estimates on assessment results (Sept 2012).

14. Investigate possible mortality effects from fish disease (Sept 2012).

15. Investigate effects of macro-algae harvesting on herring spawning habitat (Sept 2012).